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RESEARCH FOR BETTER QUALITY IN DRIED FRUITS

Apricots

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

THIS REPORT is one of four on dried fruit research conducted during 1958 and 1959 at the Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Albany 10, Calif. The Dried Fruit Industry Research Advisory Committee has worked closely with this division in support and evaluation of this research program. The assistance of the following groups is gratefully acknowledged:

California Dried Fig Advisory Board
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This report was prepared in the Western Utilization Research and Development Division, 800 Buchanan Street, Albany 10, Calif.

RESEARCH FOR BETTER QUALITY IN DRIED FRUITS

APRICOTS

F. S. Nury, D. H. Taylor, and J. E. Brekke

Dried apricots have been investigated more extensively than other dried fruits (2, 3, 5, 12)[1]. Gas changes during storage and influence of oxygen, temperature, moisture, and sulfur dioxide on their deterioration (9, 10, 11) are among the studies that have been reported. This report deals with the effect of time, temperature, and humidity of storage on the composition and quality of processed retail packages of Blenheim apricots. The work reported here is part of a project on stability of dried fruits, the main objectives of which are: 1. to provide specific information on changes that take place during deterioration of a processed product, 2. to indicate preventive measures through improved processing and handling operations, and 3. to establish new and improved quality tests and analytical methods.

Materials and Methods

The apricots used were obtained from a commercial packinghouse in the Santa Clara Valley of California in the crop year 1957, from lots that were distributed to the retail trade.

Two lots of fruits, packed in cartons with foil-laminated paper overwrap and in saran-treated cellophane bags (K202) were used. Each lot consisted of 216 twelve-ounce retail packages of medium sized Blenheim apricots of known composition (table 1). Eighteen packages from each lot were placed in each of 12 chambers maintained at constant temperatures (35°, 50°, 70°, 90° F.) and relative humidities (40, 60, 80 percent). Three packages were withdrawn at the various sampling times, which differed with temperature of the chamber.

Evaluations of quality changes were made at intervals by measurement of color, gross weight, moisture, sulfur dioxide, and sugar, and also by notations of changes in visual appearance. The methods are reported below. The experiments were continued for 5 to 16 months, depending on the conditions to which the fruits were exposed.

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[1]Numbers in parentheses refer to Literature Cited, p. 21.

Table 1.--Analyses of apricots used in the study

Determinations		Bags(K202)	Cartons
Moisture (by vacuum-oven method), pct---		32.5	32.59
Moisture (Dried Fruit Assoc. moisture meter), pct.----------		31.0	32.0
Sulfur dioxide content (p.p.m.)----------		2700	5800
Sugar content, pct.	Total----------	44.2	41.8
	Reducing----------	21.8	21.8
	Levulose----------	9.9	10.2
	Dextrose----------	11.9	11.6
	Sucrose----------	22.4	20.0
Crude fiber,[1] pct----------		2.80	2.90
Nitrogen,[1] pct----------		.57	.62
Ash,[1] pct----------		2.75	3.16
Acidity[1] (ml. of 0.1N NaOH to bring a 100-gram sample to pH 8.0)		657.8	713.7

[1]Association of Official Agricultural Chemists, Official Methods of Analysis, 8th Ed., 1955.

Alcohol Extractable Color

A 15-gram sample of well mixed ground dried fruit was placed in a 300-ml. Erlenmeyer flask containing 200 ml. of 50 percent ethanol. The flask was then covered with Parafilm[2] and allowed to remain at room temperature for 23 hours with occasional shaking. The colored solution was then filtered through Whatman No. 2 filter paper[2] and the color reading made with the aid of a Bausch and Lomb spectrophotometer (Spectronic 20)[2] at 440 mμ using a 1.2-cm. cell. The results were recorded in absorbance units ($A = \log_{10} \frac{1}{T}$) using a 50 percent ethanol solution for zero adjustment. These results were converted to a moisture-free basis (MFB) by division of the observed absorbance values by the fraction of the original sample that was total solids.

Moisture Determination

Moisture determinations were made by the vacuum-oven method. The procedure employed, with some modification, was that of the Association of Official Agricultural Chemists (1) and Makower, Chastain, and Nielsen (6). A number of analyses were also made by the Dried Fruit Association moisture meter[3] in order to compare the two methods.

[2]Mention of specific products does not constitute endorsement by the U.S. Department of Agriculture. [3]Dried Fruit Association of Calif.

In the vacuum-oven determinations a 4-gram sample of well blended ground dried fruit weighed accurately to 1 mg. was placed in a moisture dish containing 5 grams of washed and ignited coarse sand and a short stirring rod. The contents of the moisture dish were stirred and well mixed. (The rod was not removed during the course of moisture determination.) The dish was placed on a steam bath for 15 minutes and then transferred to the vacuum oven and dried for 30 hours at 60° C. at less than 2 mm. Hg. pressure. Moisture is expressed as percentage of original sample weight.

Sugars

The method of Munson-Walker (1) was employed for total and reducing sugars and that of Williams and Potter (13) for levulose determinations. Dextrose and sucrose were determined by difference.

Visual and Tactile Changes

The samples which were withdrawn for various analyses were examined for changes in texture, occurrence of sugaring, and growth of micro-organisms. In addition, color photos of a representative portion of the fruits were taken.

Weight Changes in Retail Packages

Four commercially packed retail packages of each dried fruit packed in K202 bags and four in cartons with foil-laminated paper overwrap were weighed periodically throughout the experiments to the nearest 0.5 gram. The weight changes in these unopened packages are expressed as percentage of the original weight.

Sulfur Dioxide

The sulfur dioxide content of the fruit was determined by the gravimetric Monier-Williams (7) procedure and by the Nury, Taylor, and Brekke method (8). The results included here are from the latter method.

Reflectance Color

The fruit was analyzed for reflectance color as determined by the Hunter Color and Color-Difference meter[2], which was set to a reference tile, National Bureau of Standards SBC 35, with values for Rd, a, and b, of 54.0, +1.0 and +32.0, respectively. A sample of well blended and ground dried fruit was packed 1/2 inch deep in a round cell 3.3 inches in diameter. Reflected light readings for Rd, a, and b values were taken

through a 2.25-inch circular opening in the cover plate while the sample cell rotated at about 115 r.p.m. (4).

Results and Discussion

Color Changes

Measurements of 50 percent ethanol extractable color for apricots stored at various temperatures and at 60 percent relative humidity are shown in figures 1 and 2. The effect of the different relative humidities on color changes was insignificant as compared to the effect of temperature. After 3 to 4 months at 90°F. or about 12 months at 70°F., the fruit had darkened enough to be of doubtful acceptability to the authors. The extracted color absorbance value was about 0.3. No significant changes in color were measured at either 35° or 50°F. after about 16 months of storage. The rate of darkening appeared to be about equal in most cases in both kinds of packages, despite the fact that the initial sulfur dioxide content was considerably higher in carton-packed fruits. The results of reflectance color measurements as determined by Hunter Color and Color-Difference meter (4) are shown in figures 3 and 4. The L values indicate little or no difference between fruits stored at 35° and 50°F., but show a more rapid rate of discoloration at 90°F. than can be seen from absorbance measurements. The L values appear to be more representative of the visual color changes in apricots than do other reflectance values. Initial bleaching of color at 35° and 50°F. was noted by reflectance color measurements.

Moisture and Weight Changes

Figures 5 to 10 show the gross weight changes of retail packages of apricots. Even at 80 percent relative humidity, weight losses occurred both in carton-packed and bagged ftuits. At 40 percent relative humidity, weight losses of up to 7 percent in cartons and 14 percent in bags were measured. Vacuum-oven moisture analyses of the apricots show trends somewhat similar to the weight changes although in some cases, changes do not appear to be quite as drastic as is indicated by the gross weight changes. Typical examples of the vacuum-oven moisture results are shown in figures 11 and 12 for samples stored at 35°, 50°, 70°, and 90°F. and 60 percent relative humidity. The samples stored at 80 percent relative humidity show a somewhat anomalous result in that those held at 35°F. lost more weight than those at higher temperatures. This is in agreement with the results of moisture analyses on these samples. A comparison of the Dried Fruit Association moisture meter and the vacuum-oven methods shows the latter gives slightly higher moisture values for the apricots.

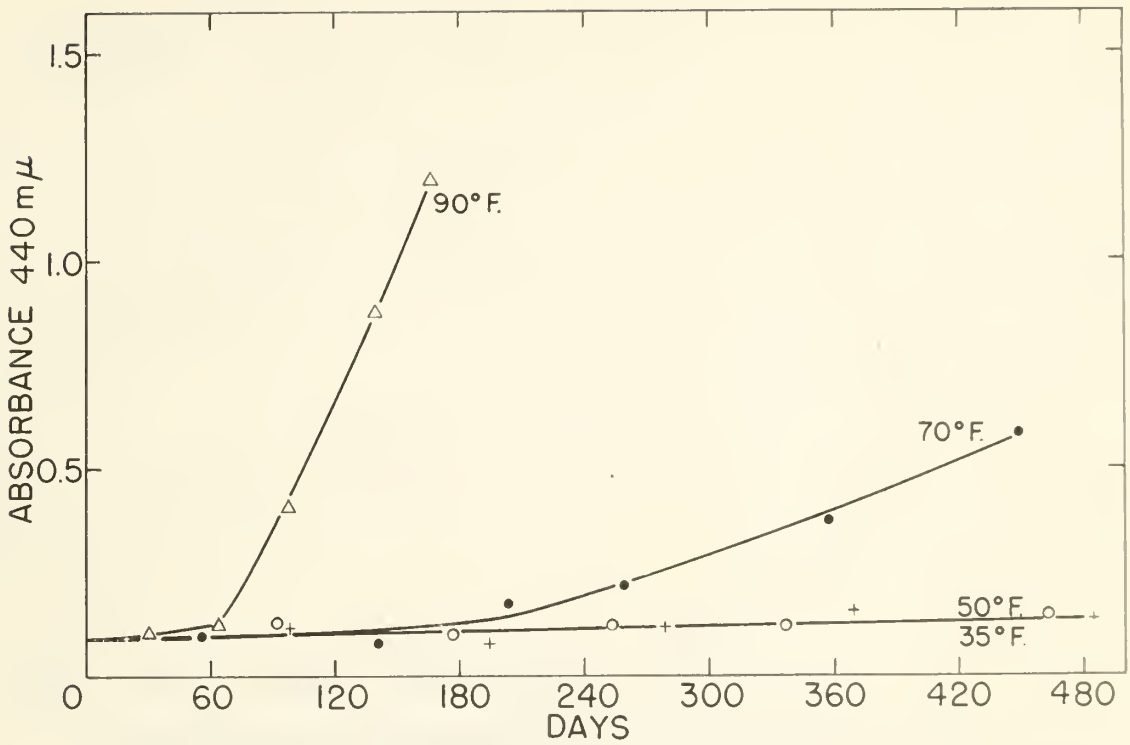

Fig. 1 Apricots, Bags, 60% RH. 50% Alcohol Extractable Color (MFB)

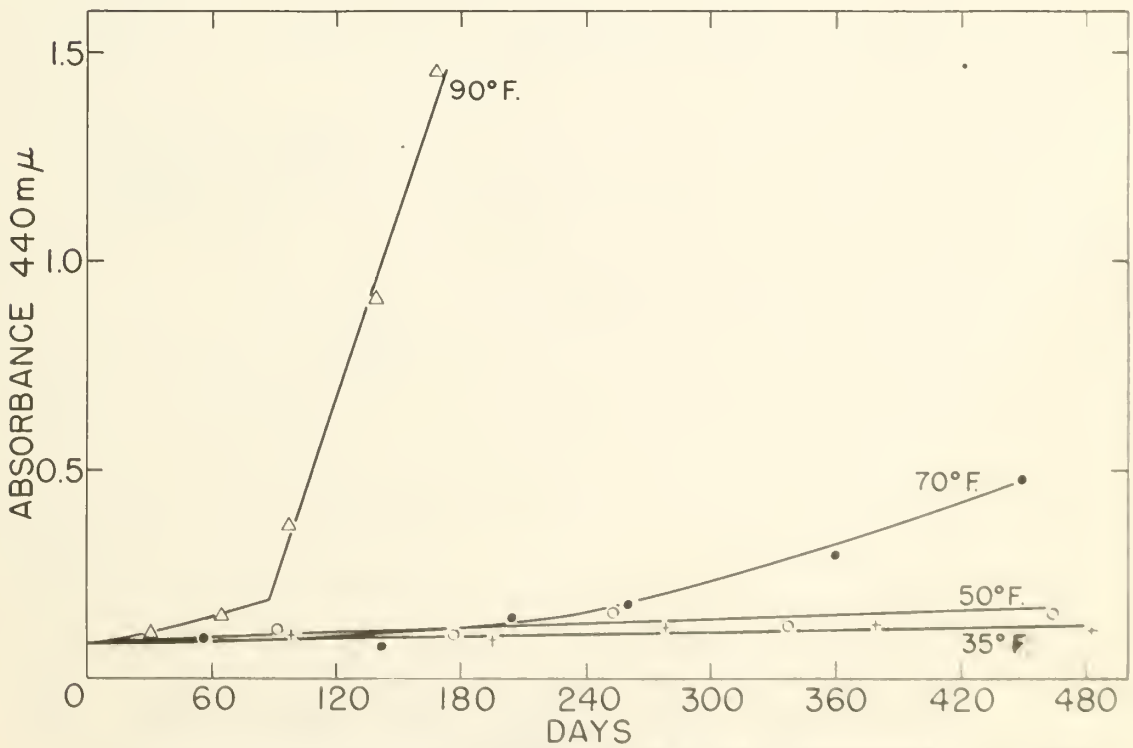

Fig. 2 Apricots, Cartons, 60% RH 50% Alcohol Extractable Color (MFB)

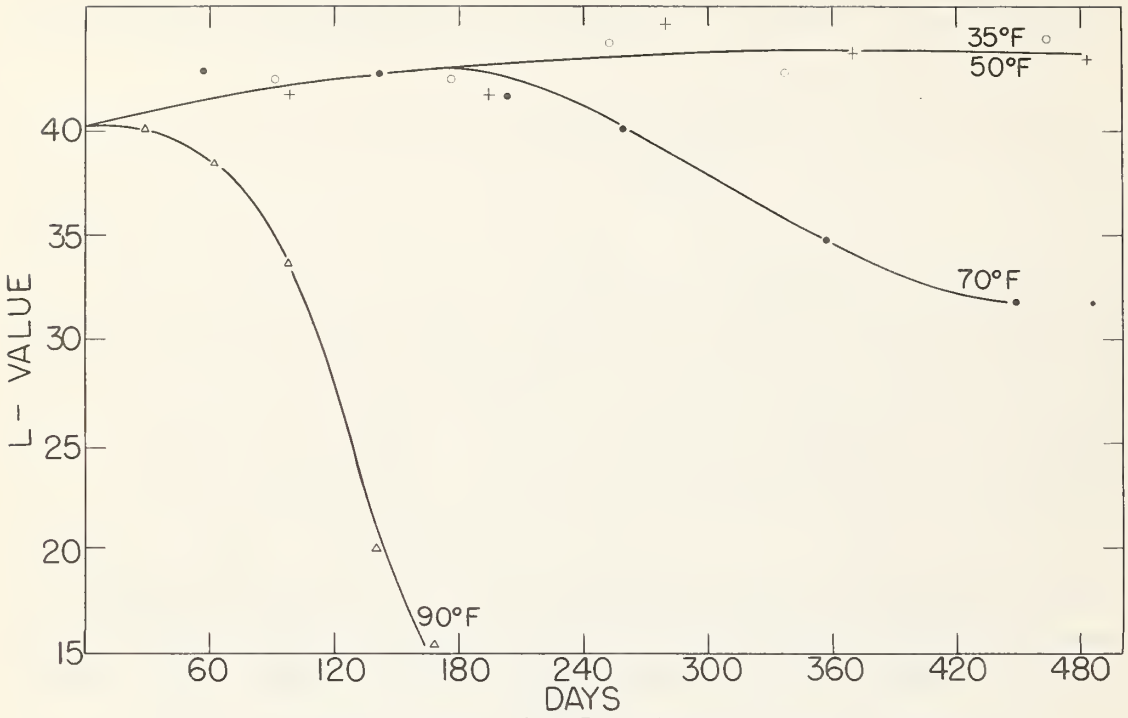

Fig. 3 Apricots, Bags, 60 % RH, Hunter Meter — Reflectance

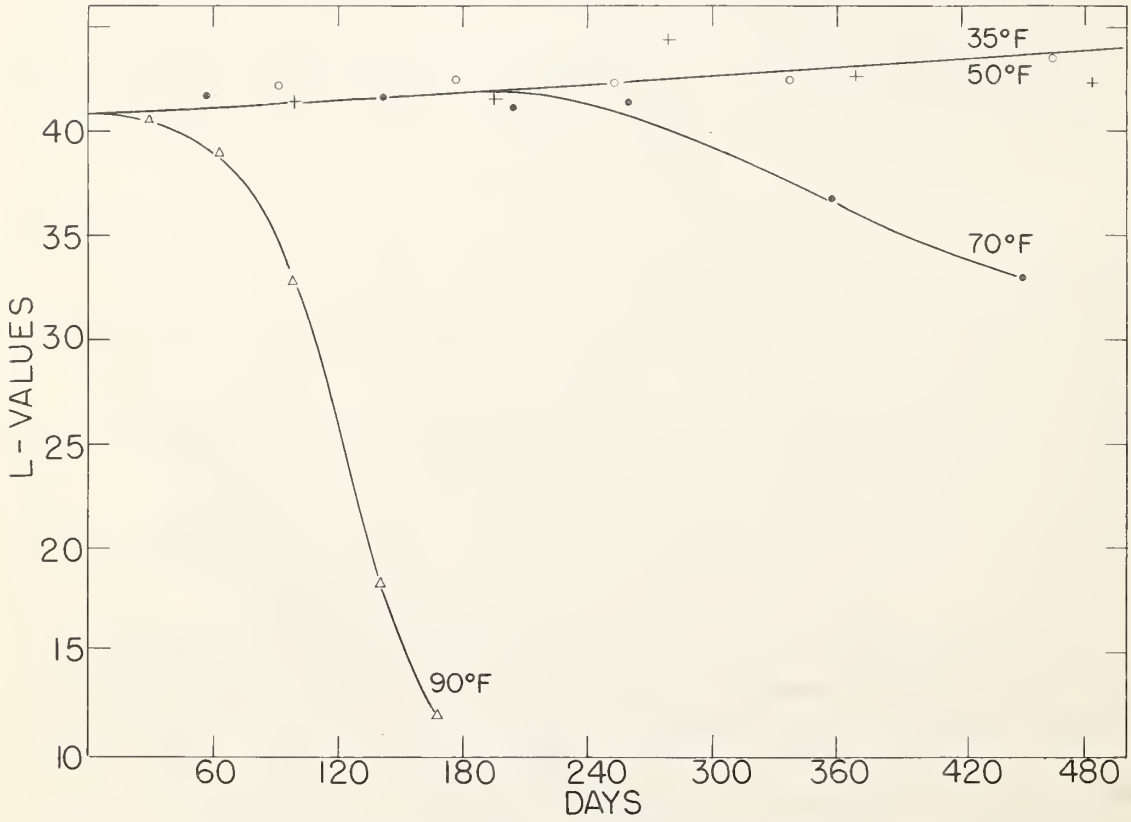

Fig. 4 Apricots, Cartons, 60% RH. Hunter Meter — Reflectance

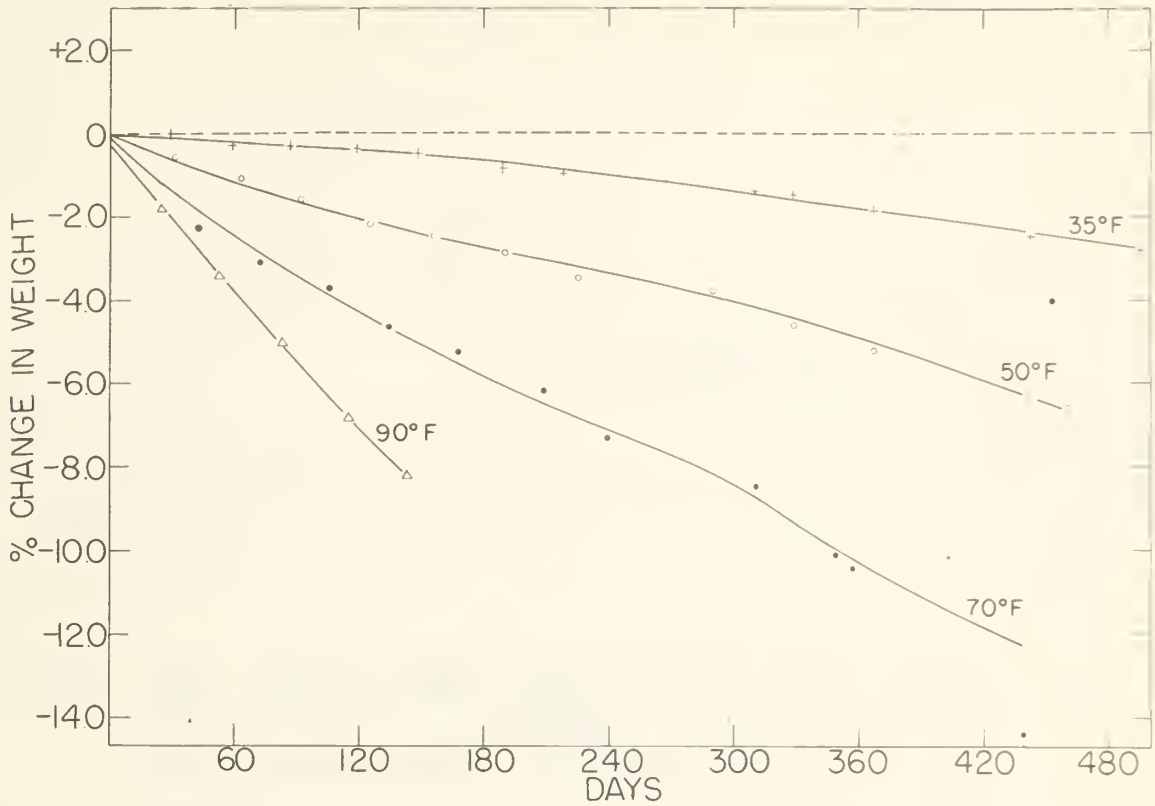

Fig. 5 Apricots, Bags, 40% RH. Percent Change in Weight

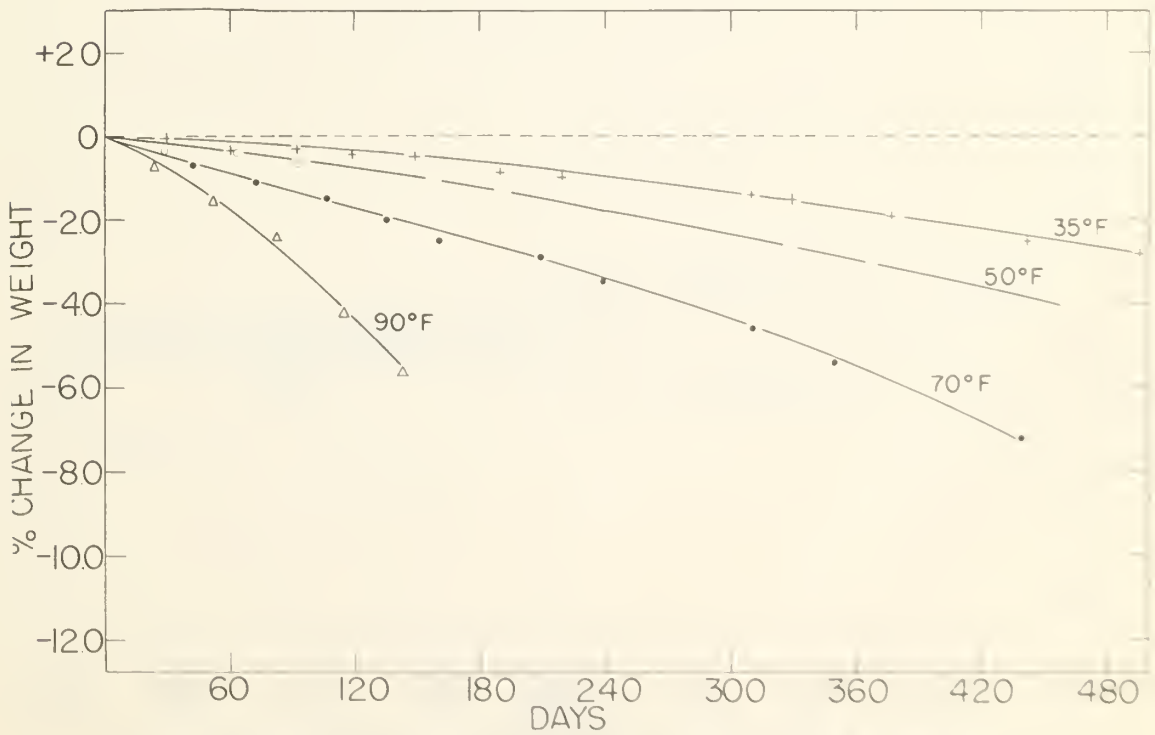

Fig 6 Apricots, Cartons, 40% RH Percent Change in Weight

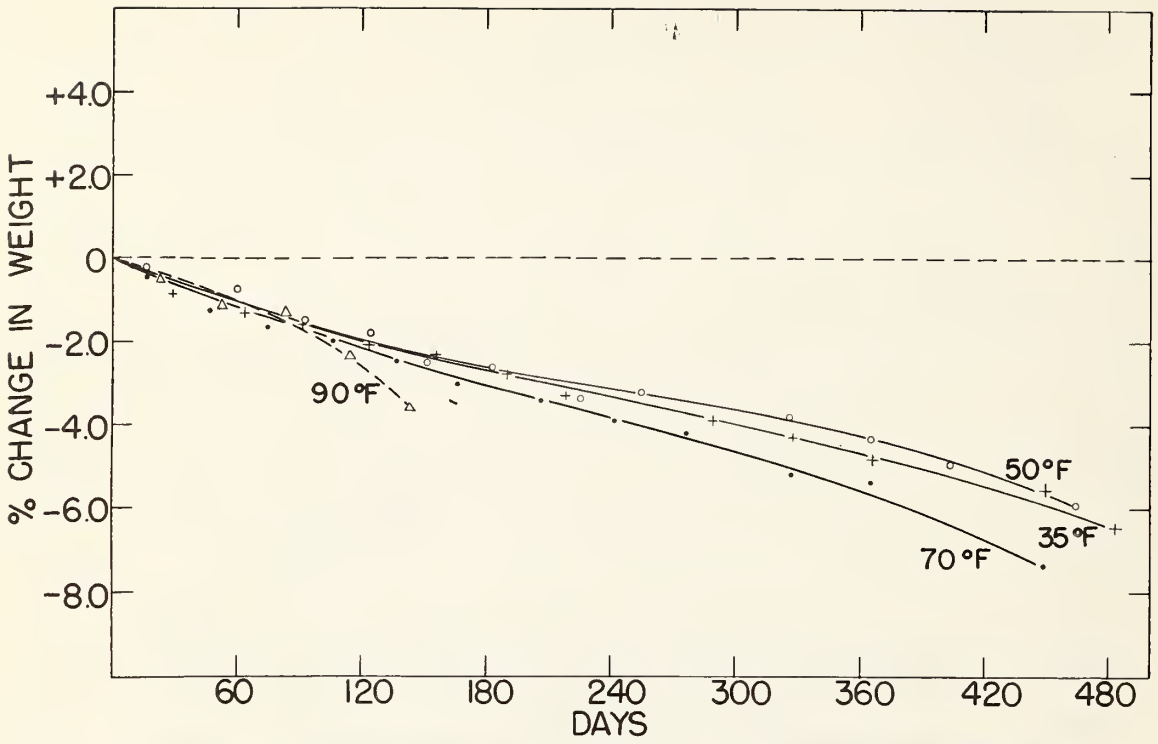

Fig. 7 Apricots, Bags 60% RH, Percent Change in Weight

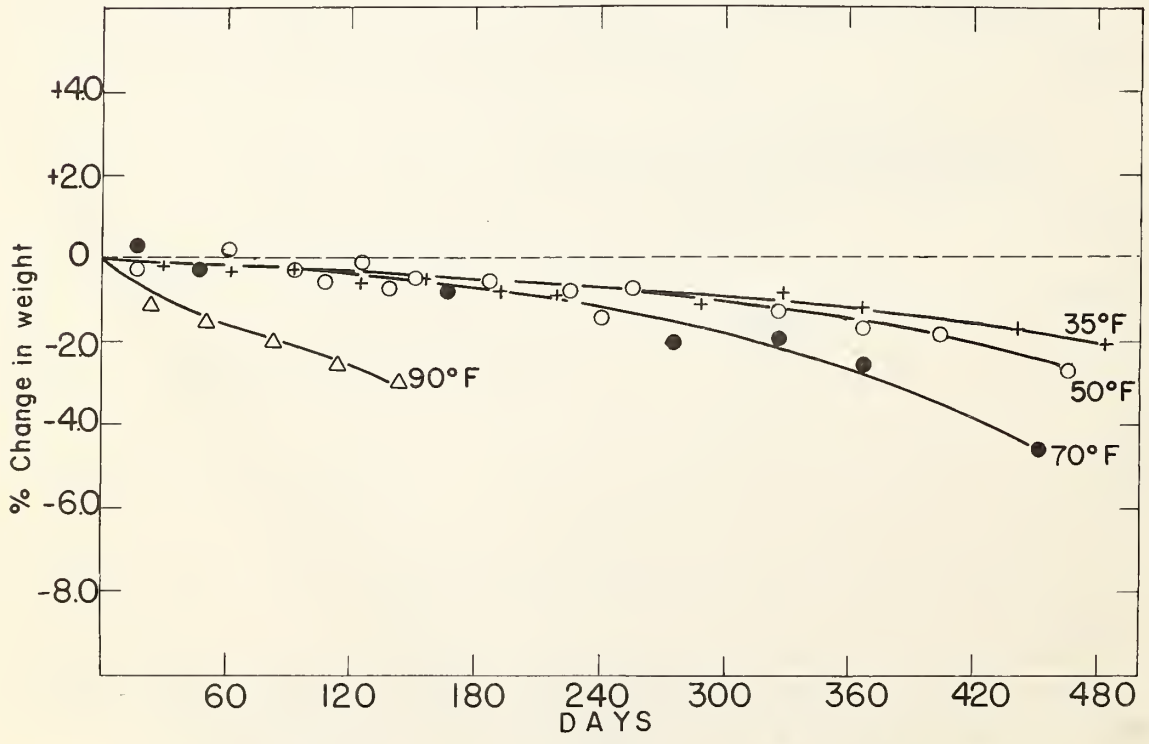

Fig. 8 Apricots, Cartons 60% RH, Percent Change in Weight

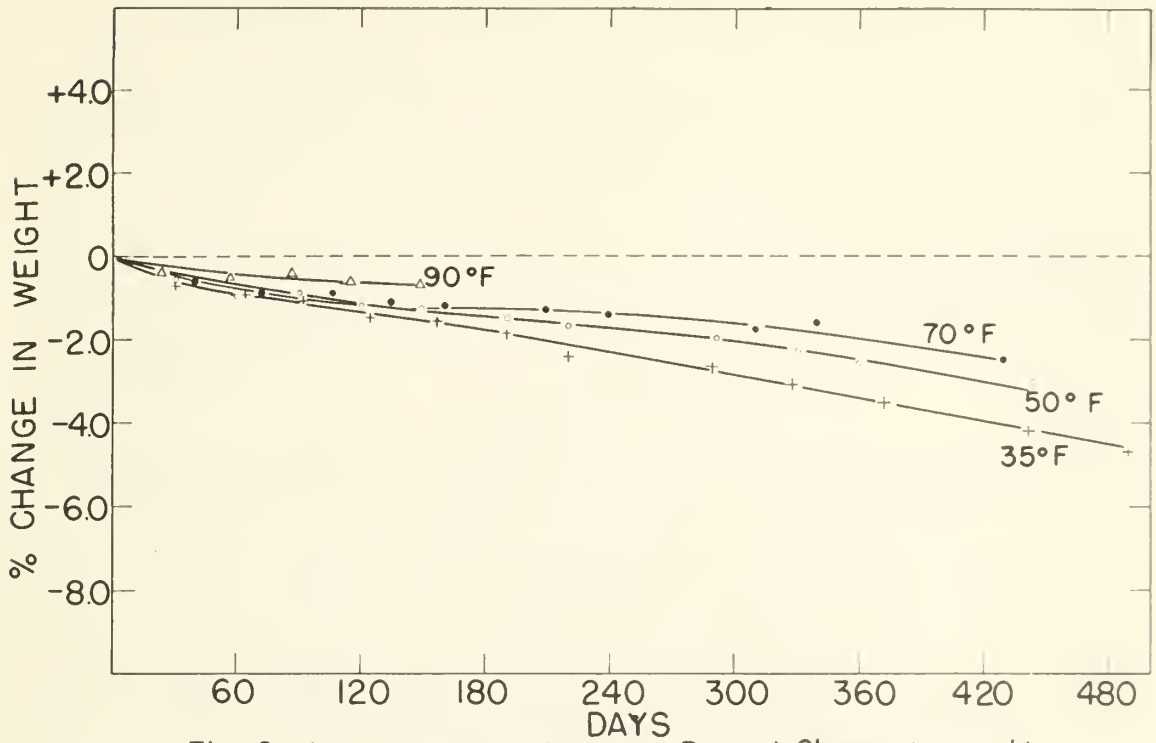

Fig 9 Apricots, Bags, 80% RH, Percent Change in Weight

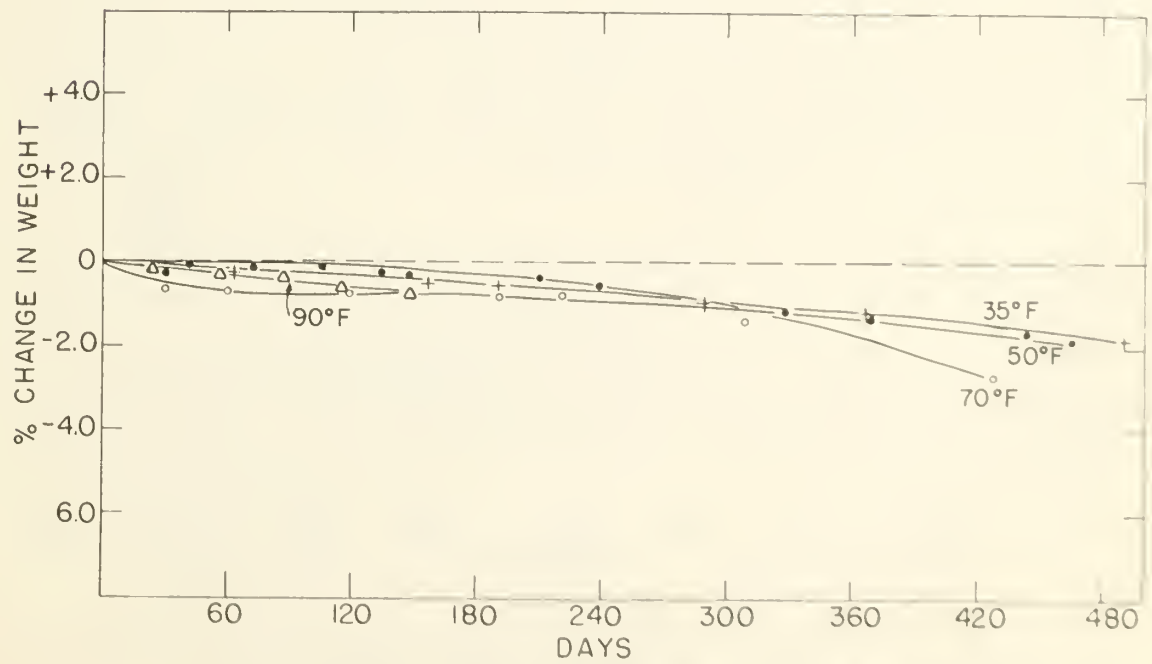

Fig 10 Apricots, Cartons, 80% RH. Percent Change in Weight

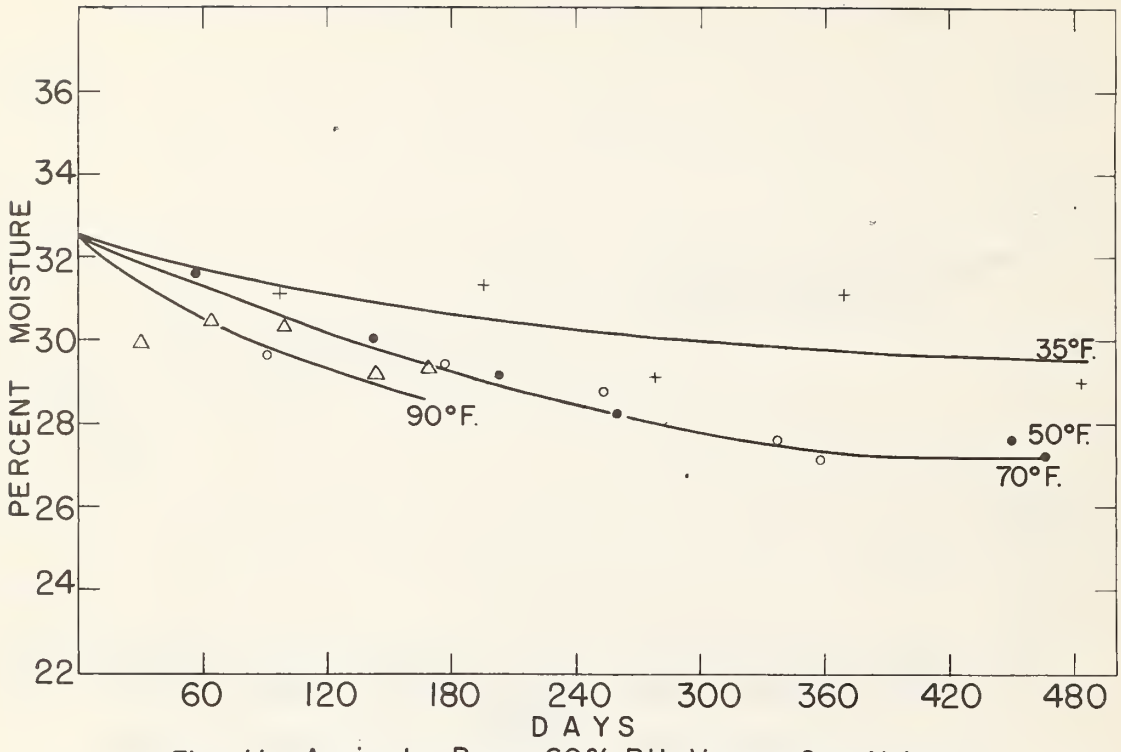

Fig. 11 Apricots, Bags, 60% RH Vacuum Oven Moisture

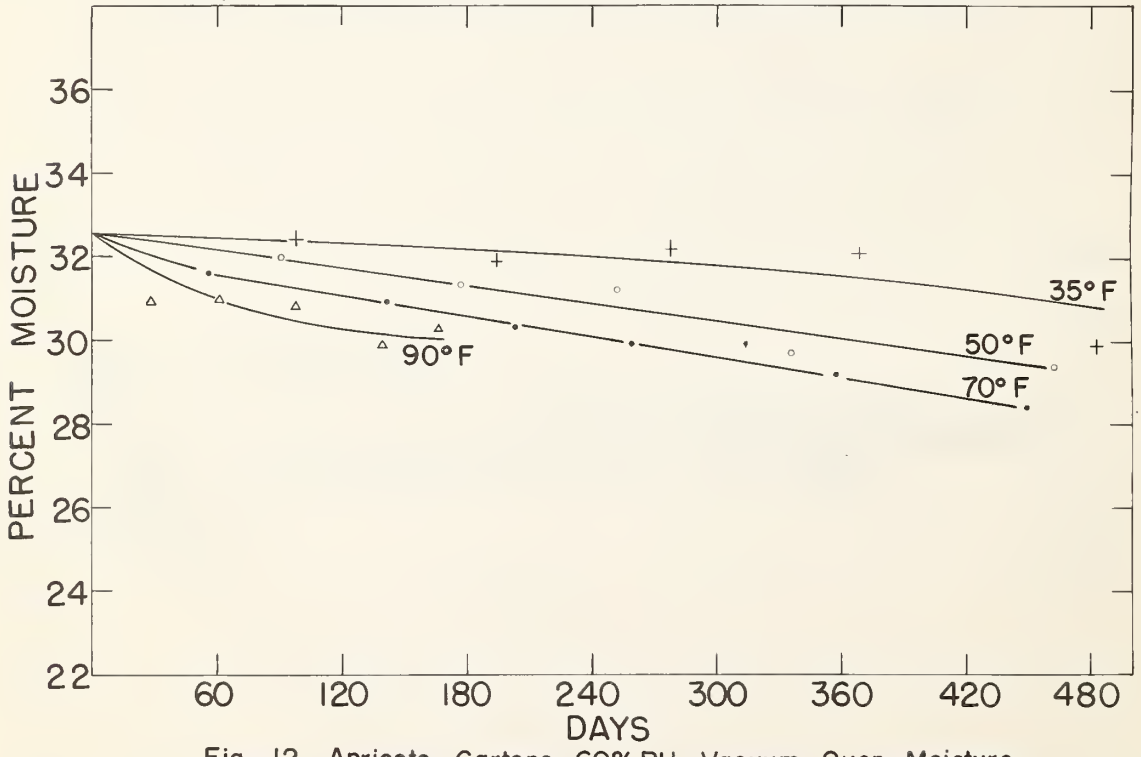

Fig. 12 Apricots, Cartons, 60% RH, Vacuum Oven Moisture

Sugar Content Changes

The analyses of total and component sugars of apricots indicate a gradual inversion of the sucrose and a simultaneous increase in reducing sugars; this is directly dependent on temperature of storage. Figures 13 to 16 show the results for the fruits stored at 60 percent relative humidity and at 35°, 50°, 70°, and 90° F. Inversion appears to be nearly completed after 2 months and 6 months at 90° and 70° F., respectively, but at 50° and 35° F. much longer periods of storage than 16 months would be required to bring about complete inversion.

Sulfur Dioxide Changes

Figures 17 to 22 represent the changes in amount of sulfur dioxide in apricots stored under various atmospheric conditions. As was noted previously, the carton-packed apricots in this study had a much higher sulfur dioxide content than the bagged fruits and thus the comparison of package-types in relation to sulfur dioxide changes must be made with this latter fact in mind. The results indicate higher sulfur dioxide retention at lower temperatures. It is also indicated that initial sulfur dioxide content in the range of about 4,000 to 8,000 p.p.m. (moisture-free basis) does not proportionately affect the quantity retained by the fruit. That is, the rate of loss is much higher for fruits containing large amounts of sulfur dioxide. Therefore, a heavily sulfured fruit does not appear to have protection of a magnitude proportional to the sulfur dioxide content, at least in the range indicated above. This may be due to the fact that at high levels, much of the sulfur dioxide exists as free molecules which readily escape from the fruit; at lower levels, a greater proportion of the sulfur dioxide may be retained in the form of a bisulfite addition product with sugar.

Visual Changes

Periodic visual examinations of the apricots indicated little change in their appearance, with the exception of the obvious color changes which have been discussed. No sugaring, no growth of micro-organisms, and no insect infestation occurred throughout the experiments. However, a softening of the texture upon aging of the fruits at 70° and 90° F. occurred, despite the fact that the moisture content remained nearly the same, or decreased.

Summary

The results of a study of time-temperature-humidity tolerance of processed retail packages of dried Blenheim apricots is presented. It

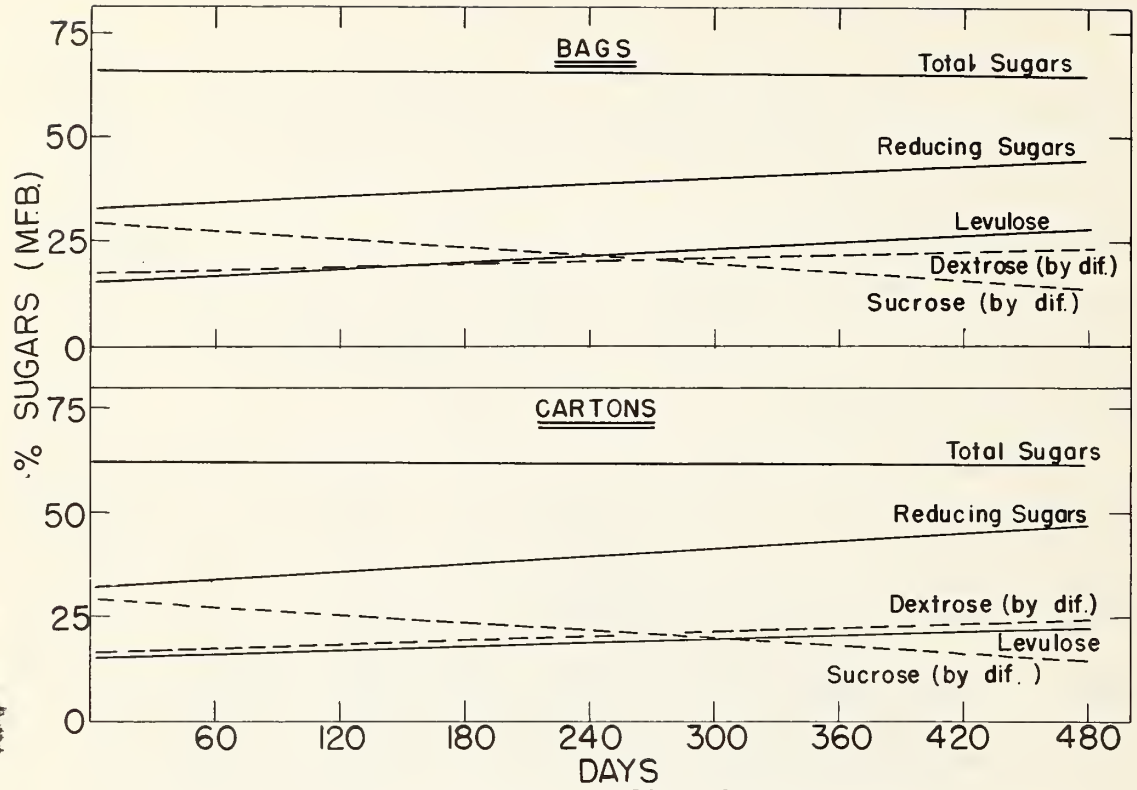

Fig. 13 Apricots, 35°F 60% RH, Sugars

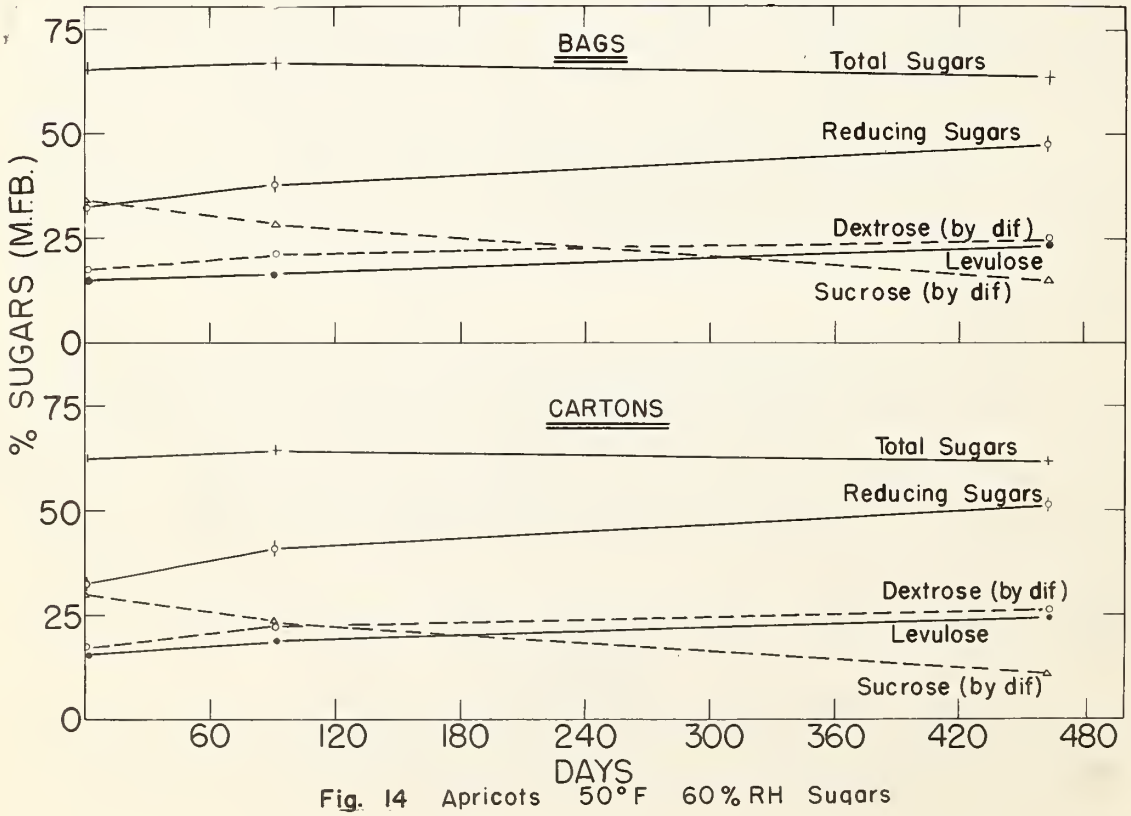

Fig. 14 Apricots 50°F 60% RH Sugars

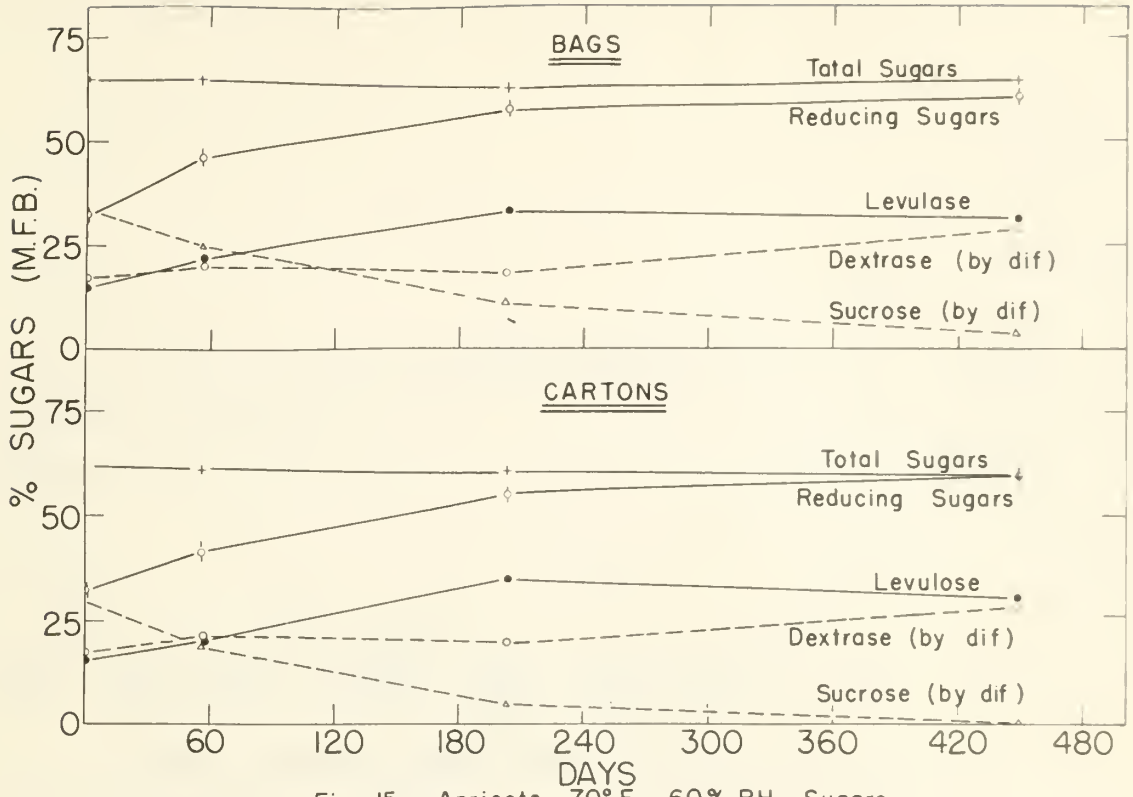

Fig. 15 Apricots 70° F 60% RH Sugars

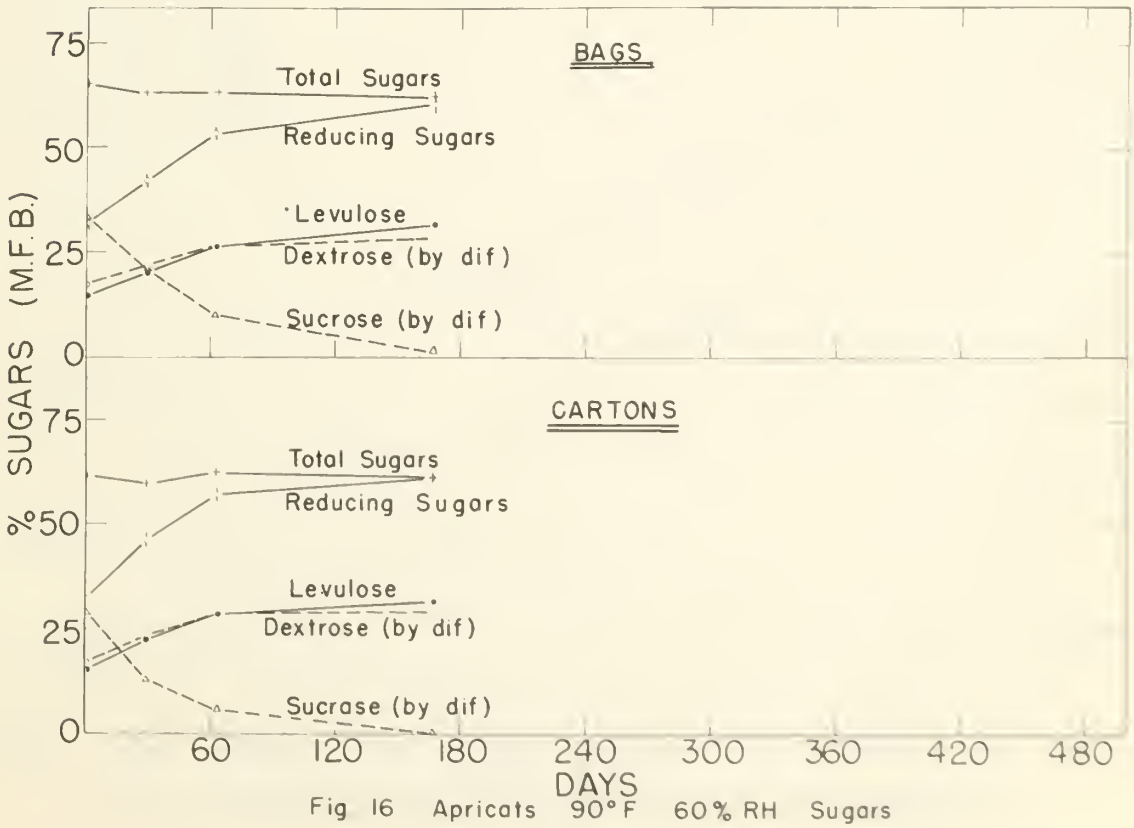

Fig 16 Apricats 90° F 60% RH Sugars

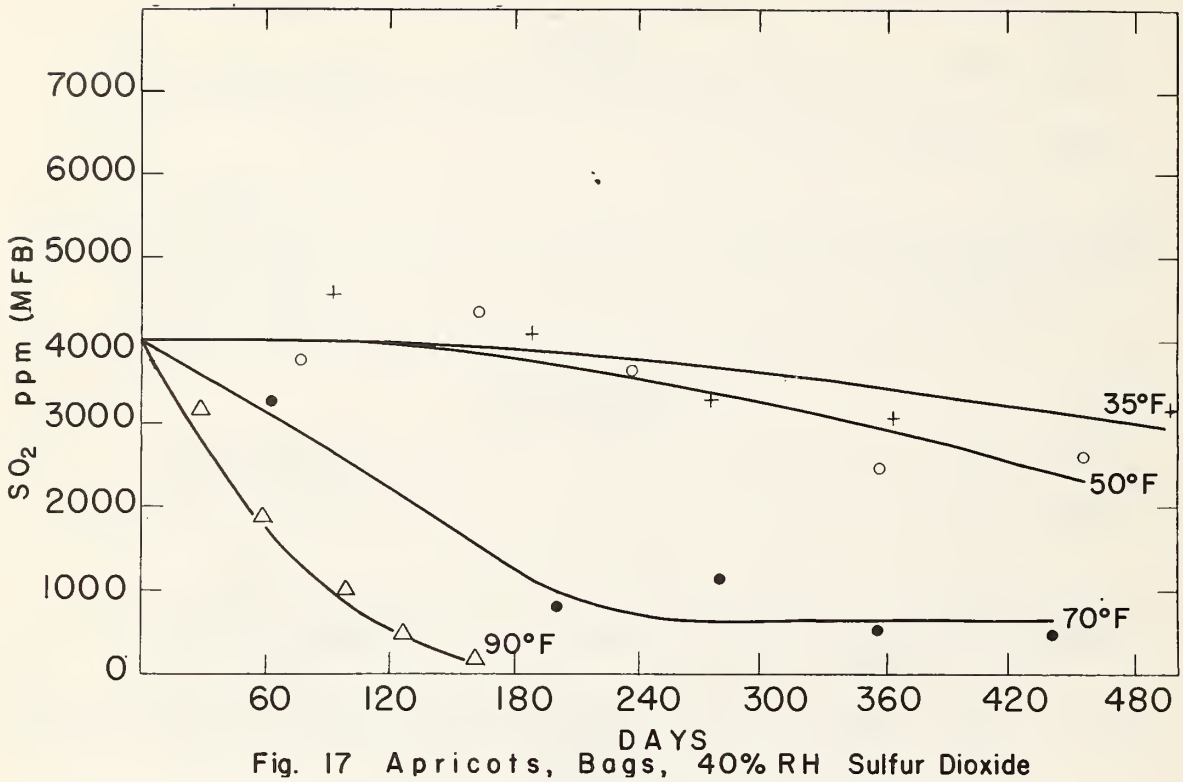

Fig. 17 Apricots, Bags, 40% RH Sulfur Dioxide

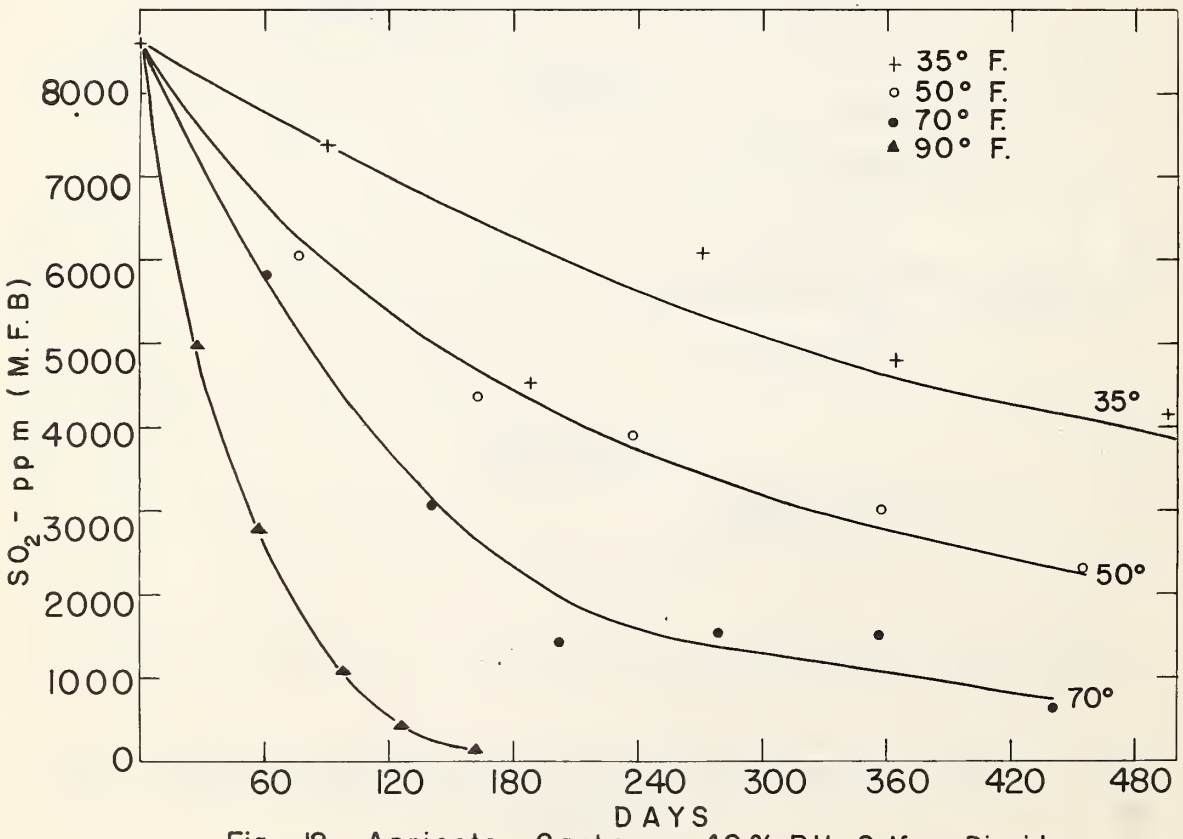

Fig. 18 Apricots, Cartons, 40% RH Sulfur Dioxide

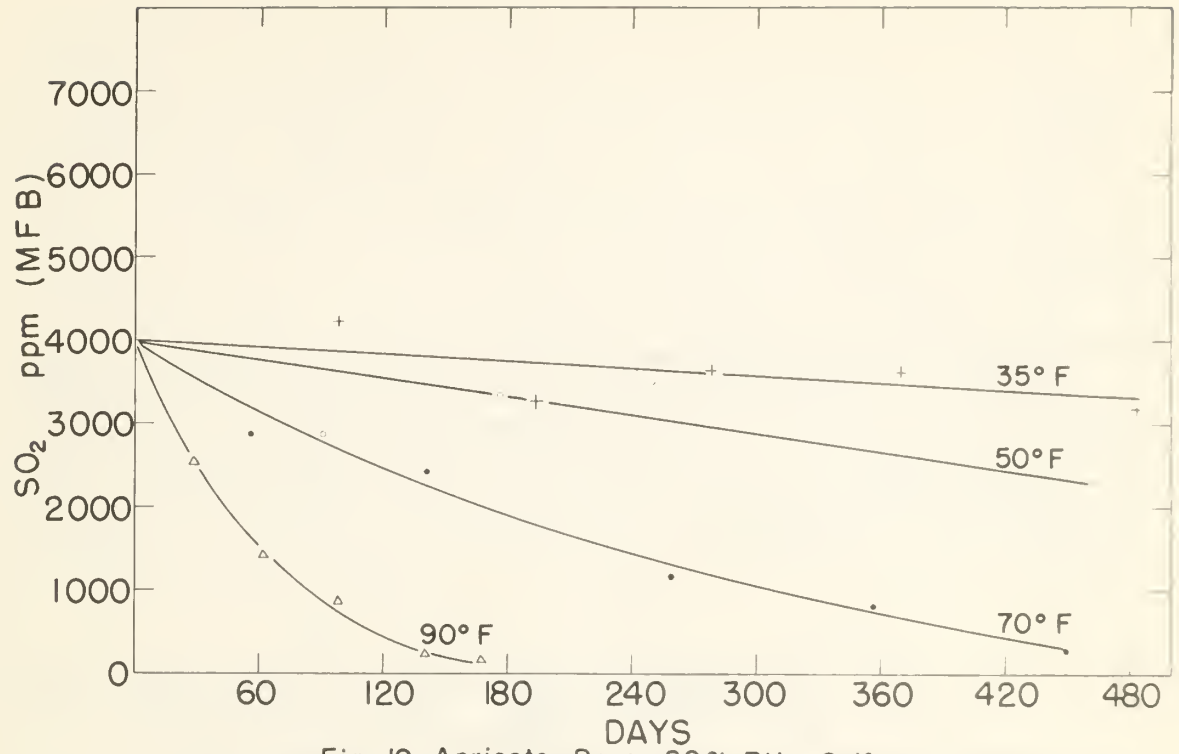

Fig. 19 Apricots, Bags, 60% RH, Sulfur Dioxide

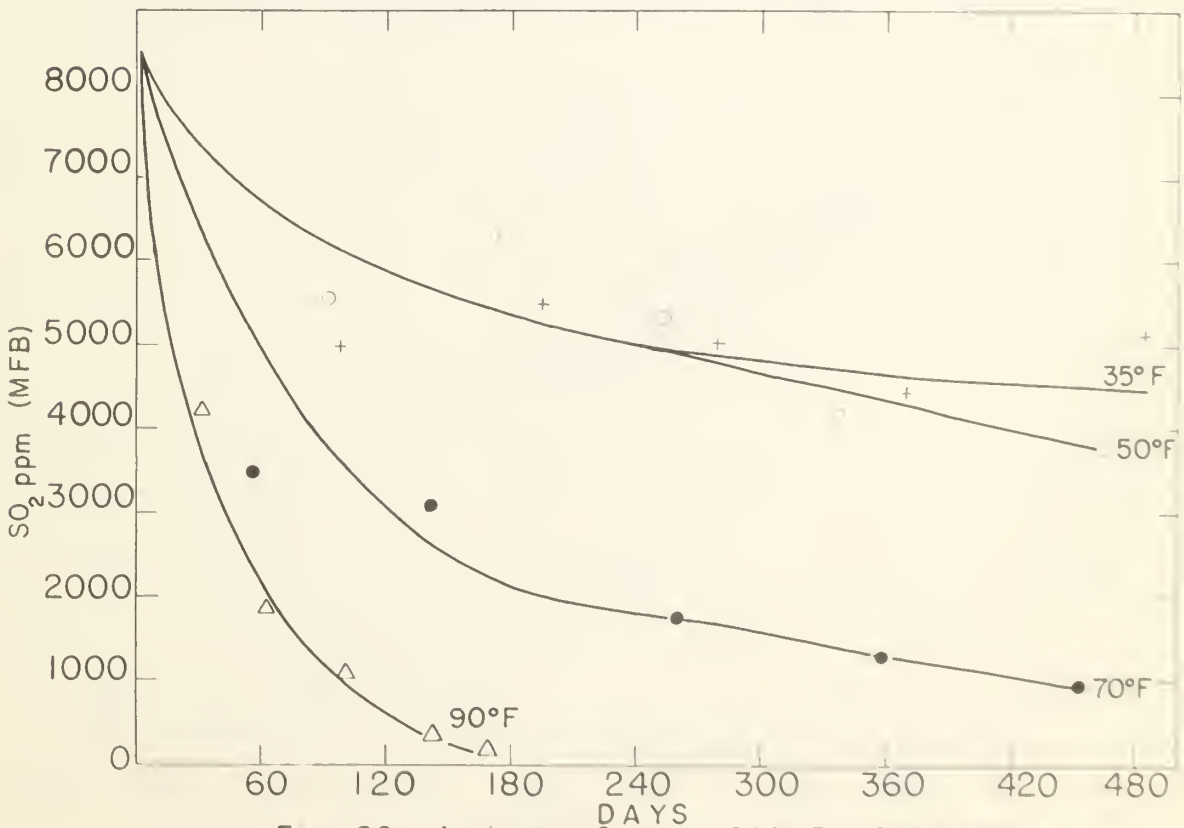

Fig. 20 Apricots, Cartons 60% RH Sulfur Dioxide

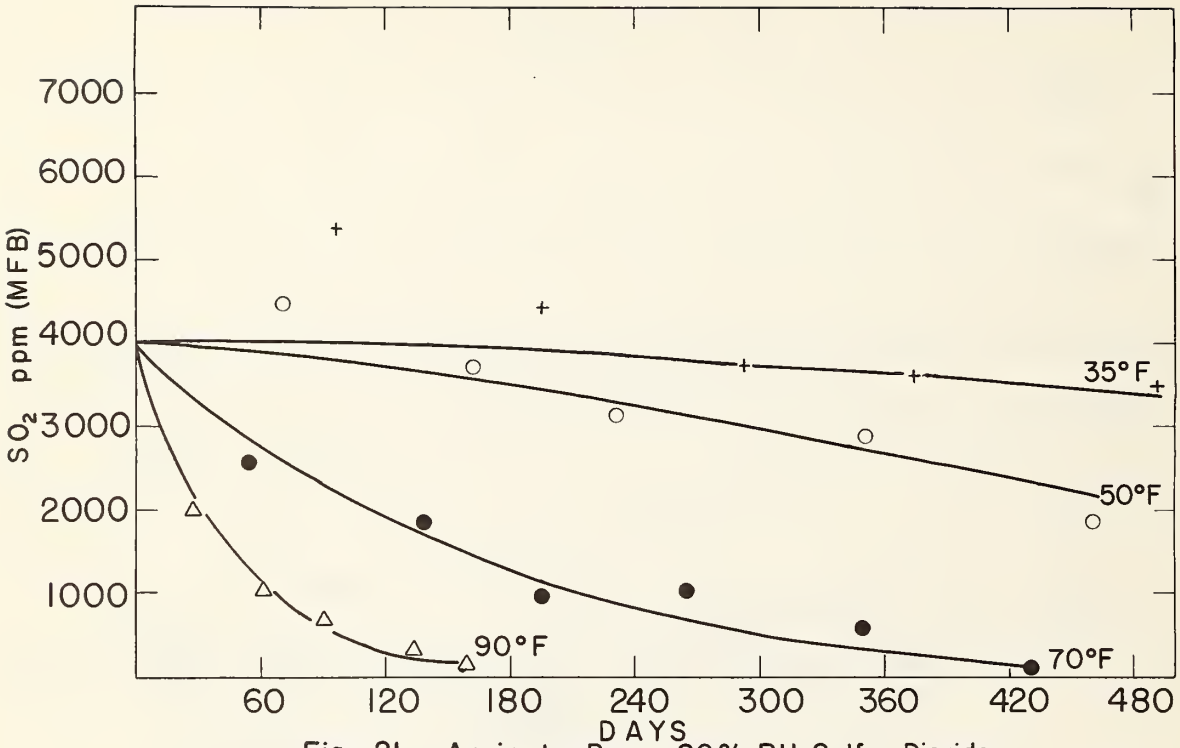

Fig. 21 Apricots, Bags 80% RH Sulfur Dioxide

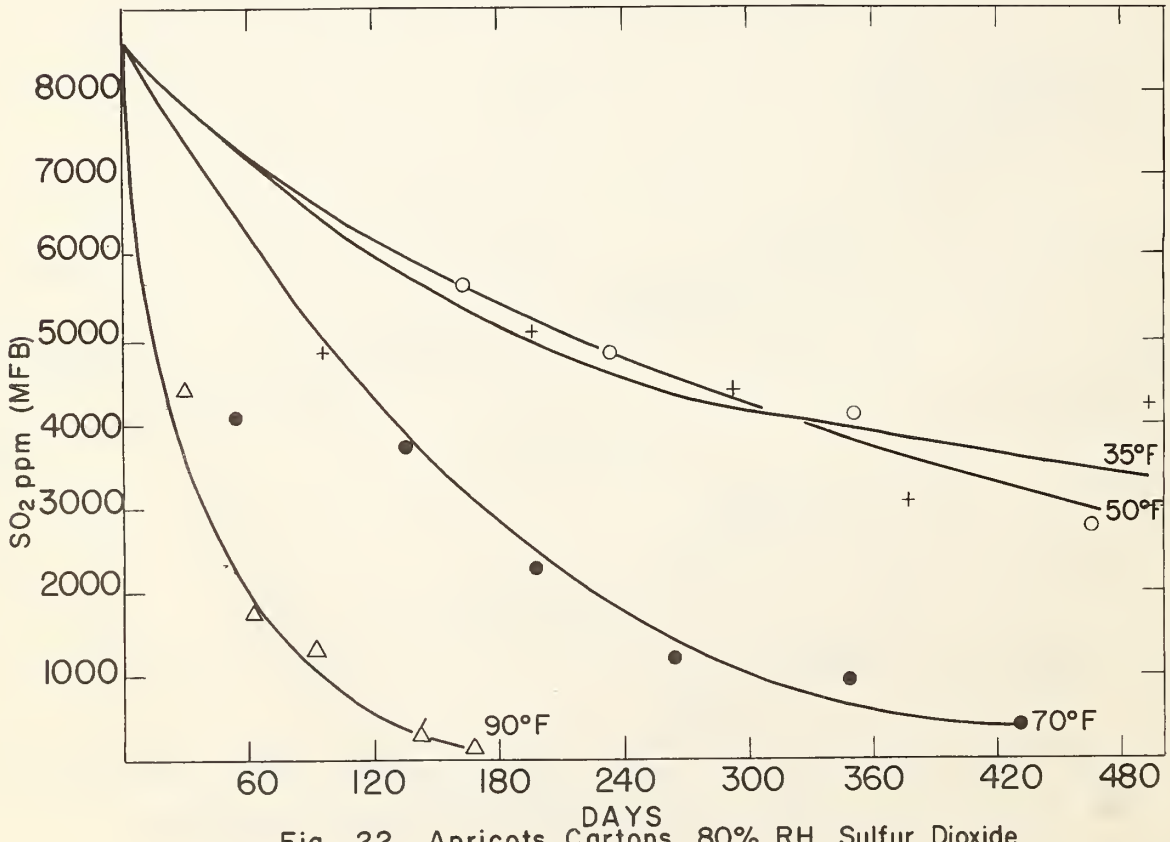

Fig. 22 Apricots, Cartons 80% RH Sulfur Dioxide

is shown that color changes and sulfur dioxide changes are related to temperature of storage, and weight or moisture changes are associated with temperature and relative humidity of the atmosphere. Inversion of the sucrose in apricots is nearly complete at 90° and 70°F. after 2 and 6 months respectively, but occurs at a much lower rate at 50° and 35°F. Based on the results of these experiments, quality retention is best maintained at 35° and 50°F. After 16 months of storage at these temperatures, the fruit was of excellent quality in the carton packs, and, aside from some drying at low humidity, equally good quality was maintained in the K202 bags. Storage at 70°F. did not adversely affect the quality of the products for about 8 months. Higher humidity of storage which retards dehydration of these processed high moisture fruits, was advantageous for general retention of quality at 70°F. At 90°F. the fruits were of poor quality after 90 days of storage regardless of package type or humidity of the atmosphere to which they were exposed.

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